Effect of Closing the GIWW Below Corpus Christi Bay on Expenditures for Transportation Service

by

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Table of Contents

List of Tables

List of Figures

Effect of Closing the GIWW Below Corpus Christi Bay on Expenditures for Transportation Service

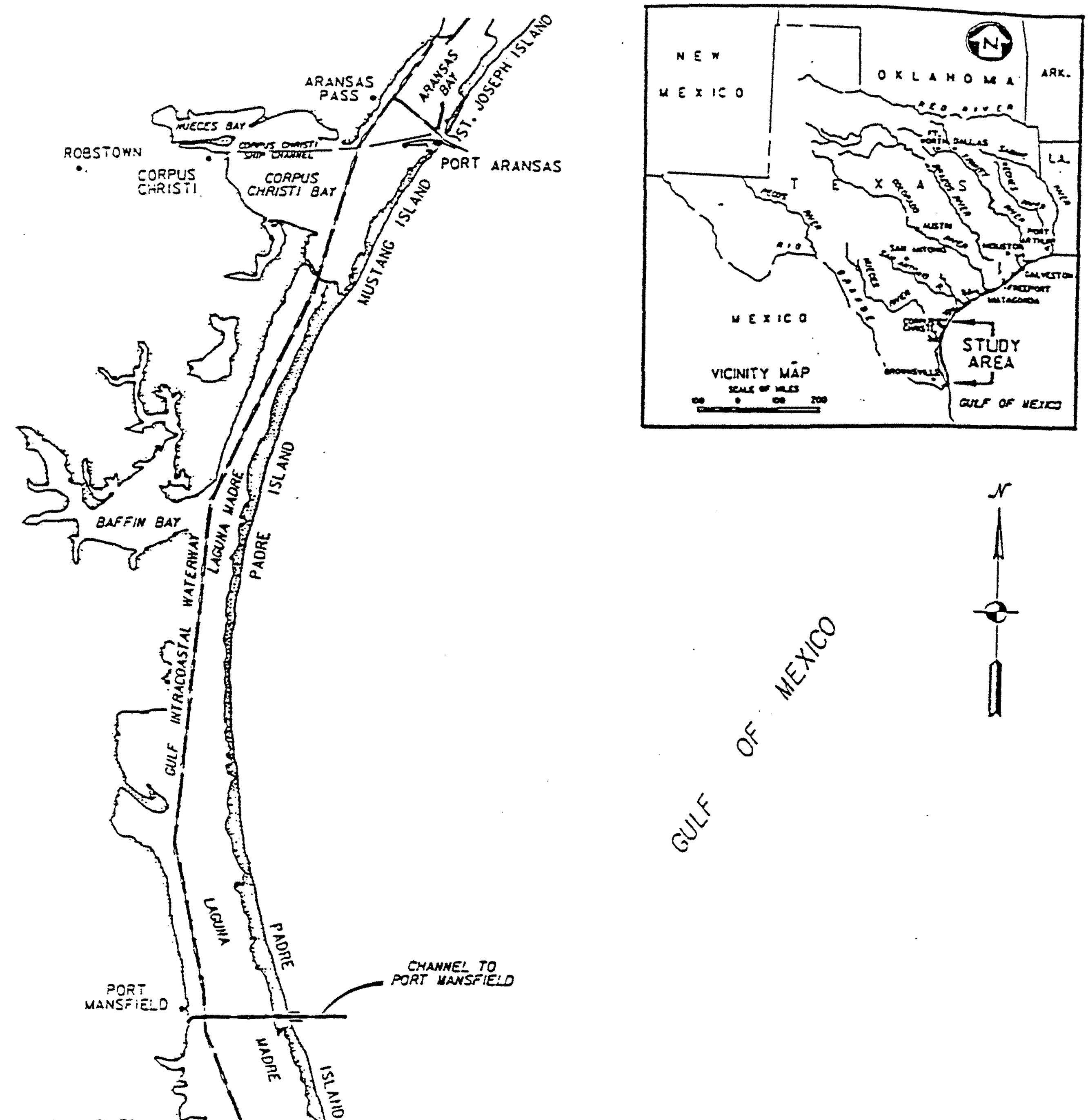
Introduction

The Gulf Intracoastal Waterway (GIWW) is a 1300 mile transportation artery that extends from near Brownsville, Texas to St. Marks, Florida. The Texas portion of this protected waterway extends from the Texas/Louisiana border near Orange, Texas to Port Isabel near Brownsville. This waterway links Texas ports with other Gulf ports and the inland waterway system of the United States via shallow draft barge transportation (Figure 1). This study focuses on the economic implications of abandoning the GIWW below Corpus Christi Bay (Figure 2). In particular, the objective of this portion of the study is to estimate the change in expenditures for transportation service that would likely result if firms no longer had access to this portion of the GIWW.

Research Procedure

Four scenarios are developed and evaluated for purposes of accomplishing study objectives. The first scenario attempts to measure total transport cost associated with the current shallow draft barge transportation system that traverses the GIWW below Corpus Christi Bay. This transport cost estimate will serve as a benchmark or baseline estimate to be compared with transport costs of the second scenario. The second scenario attempts to measure total transportation costs of alternative mode and mode combinations that would likely be adopted if the GIWW below Corpus Christi Bay were to be closed. Total transportation costs from scenarios 1 and 2 will be contrasted to offer insight on the transportation cost benefits

Figure 1. Inland Navigation System of United States



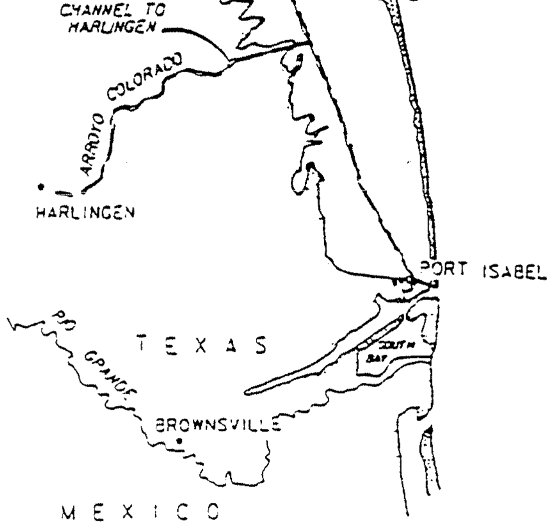
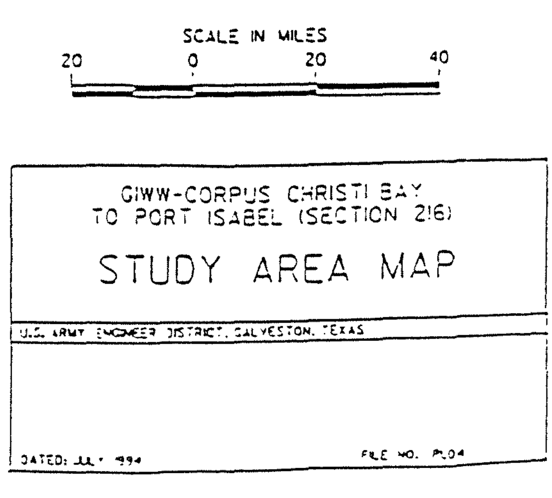


Figure 2. The GIWW Below Corpus Christi Bay



associated with the examined portion of the GIWW. It is assumed that the measured change in transport costs (scenario 1 vs. scenario 2) would approximate the change in expenditures for transportation services. Because of a recently proposed refined petroleum pipeline that is to connect refineries in the Corpus Christi area to the lower Rio Grande Valley it was necessary to develop two additional scenarios. The third scenario is designed to estimate the refined petroleum product market share and total transport costs of shallow draft barge operations given the introduction of the proposed pipeline. The fourth scenario attempts to measure total transport costs of alternative transport modes and mode combinations that would likely result with closure of the GIWW below Corpus Christi Bay given operation of the proposed pipeline. By contrasting scenarios 3 and 4, the transportation cost savings of the shallow draft barge system operating below Corpus Christi Bay can be evaluated in view of the proposed refined petroleum product pipeline.

Transhipment models will be constructed for scenarios 2, 3, and 4. The solution to the transhipment models will be obtained to identify total transportation cost and least-cost flow patterns. The estimated benchmark costs (scenario 1) and projected costs for scenarios 2, 3, and 4 will be contrasted for purposes of estimating the transportation cost benefits associated with the GIWW below Corpus Christi Bay. In particular, the estimated benchmark costs (scenario 1) will be contrasted with costs associated with scenario 2 to measure the transportation cost savings associated with the shallow draft barge system operating on the GIWW below Corpus Christi Bay given the current transportation environment, i.e., absent the proposed pipeline that is to connect Corpus Christi to the lower Rio Grande Valley. Scenarios 3 and 4 will be contrasted to estimate transportation cost savings for refined petroleum products that result from shallow draft barge operations on the GIWW given the operation of the proposed pipeline.

All barge, rail and truck cost estimates will be obtained with the Reebie transportation costing models while ocean barge costs will be obtained by updating existing off-shore barge cost budgets. Pipeline costs/tariffs will be estimated in consultation with industry personnel.

Interregional Trade Flows Involving Affected Portion of GIWW

The Waterborne Commerce Statistics show an average of 2.25 million tons of freight transported via the GIWW below Corpus Christi, Texas during the 1994-1996 period (Table 1). Approximately 83 percent of the tonnage originated on other portions of the United States inland waterway system and was transported to the studied segment, thus representing a downbound move. The remaining 17 percent of tonnage originated on the affected segment and was transported to destinations on other portions of the U.S. inland waterways, thus an upbound movement (Table 1). There were no significant intrasegment movements of freight on the GIWW below Corpus Christi during the 1994-1996 period.

To develop perspective on various regions of the United States that trade with the south Texas region via barge transportation, the Waterborne Commerce data relating flows was segregated into downbound movements (tonnage destined for the GIWW), upbound movements (tonnage shipped from GIWW) and associated states involved in these flows. The analysis showed Texas originated about 85 percent of the tonnage destined for the GIWW (downbound) while Louisiana and Pennsylvania originated about 9 and 3 percent, respectively. Louisiana was found to be the primary destination for commerce shipped from the affected portion (upbound) of

Table 1. Estimated Interregional Trade Flows Involving the GIWW Below Corpus Christi Bay (1,000 short tons)

Origin of Traffic Shipped to GIWW (Downbound)						
	1994	%	1995	%	1996	%
Texas	1,660	84.0	1,458	84.2	1,627	85.9
Louisiana	203	10.3	157	9.0	124	6.6
Pennsylvania	35	1.7	60	3.5	63	3.3
Mississippi	32	1.6	14	0.8	11	0.6
West Virginia	12	0.6	10	0.6	11	0.6
Tennessee	11	0.6	1	0.1	0	0.0
Indiana	7	0.4	0	0.0	14	0.7
Iowa	6	0.3	1	0.1	3	0.2
Missouri	4	0.2	5	0.3	0	0.0
Arkansas	2	0.1	21	1.2	2	0.1
Illinois	2	0.1	0	0.0	7	0.4
Kentucky	2	0.1	0	0.0	21	1.1
Other	0	0.0	4	0.2	10	0.5
Total	1,976	100.0	1,731	100.0	1,893	100.0
Destination of Traffic Shipped from GIWW (Upbound)						
	1994	%	1995	%	1996	%
Louisiana	226	55.4	166	40.6	153	46.1
Texas	130	31.9	200	49.0	111	33.4
Tennessee	33	8.2	29	7.1	27	8.2
Illinois	14	3.4	7	1.7	17	5.1
Pennsylvania	2	0.5	3	0.7	0	0.0
Ohio	0	0.0	0	0.0	7	2.1
Kentucky	1	0.2	0	0.0	3	0.9
Alabama	0	0.0	3	0.7	11	3.3
Indiana	1	0.2	1	0.2	3	0.9
Other	1	0.2	0	0.0	0	0.0
Total	408	100.0	409	100.0	332	100.0

Source: Waterborne Commerce Statistics obtained from Waterborne Commerce Statistics Center, New Orleans, Louisiana the GIWW with a 47 percent share. Texas ranked as the second most important destination for shipments with a 38 percent share followed by Tennessee (8 percent) and Illinois (3 percent). Clearly, Texas is the leading trading partner with the south Texas region. In particular, about 77 percent of the barge-transported traffic on the GIWW below Corpus Christi involves trade with other Texas regions while 15 percent involves trade with Louisiana.

During the 1994-1996 study period, about 51 percent of the annual tonnage (2.25 million tons) transported via the studied portion of the GIWW was either originated or terminated at the Port of Brownsville while the Port of Harlingen originated/terminated about 43 percent of all traffic. Remaining tonnage transported via the studied portion of the GIWW originated/terminated at the Port of Isabel (5 percent) and Port Mansfield (1 percent).

Major Commodity/Product Flows on GIWW

This section offers insight on major commodity/product flows on the GIWW below Corpus Christi, Texas over the 1994-1996 period. The descriptive analysis examines major commodity/product groups which represent downbound and upbound movements. Initial focus is on the downbound movement which represents about 73 percent of total transported tonnage (Table 2).

Downbound Flows

About 75 percent of the downbound tonnage was refined petroleum products; about 80 percent of this tonnage was gasoline with the remaining diesel and fuel oil (16 percent) and lubricating oil (4 percent) (Table 2). The bulk of the refined petroleum products originate in

Corpus Christi and the Houston, Galveston, Texas City and Baytown, Texas area. In particular, Corpus Christi refineries ship about 93 percent of the southbound refined petroleum product while other Texas refineries ship about 5 percent. Remaining refined petroleum products originate in Louisiana and the upper reaches of the Ohio River (Pennsylvania, Ohio and West Virginia). An estimated 55 percent of the refined petroleum products were destined to the port at Brownsville with the remainder (45 percent) transported to the Harlingen area.

During the 1994-1996 study period, about 10 percent of the downbound movement was comprised of sand and gravel. About 95 percent of this tonnage originated on the Guadalupe River near Victoria, Texas. The primary destination for these downbound movements was Port Isabel which received about 75 percent of all sand and gravel shipments.

Primary iron and steel products were estimated to make up about 7 percent of all downbound movements. This grouping included spools of flat-rolled steel, metal ingots and pig iron. Virtually all products moved to Brownsville for subsequent export to Mexico. About half of these products originated on the upper reaches of the Ohio River and the Monongahela River (Pennsylvania, West Virginia, Ohio). Louisiana supplied about 37 percent of the total supply of these products while the remaining supplies originated in Texas (8 percent) and Illinois (5 percent).

Liquid and dry fertilizers comprised about 6 percent of the downbound tonnage and because of drought in the lower Rio Grande Valley during a portion of the 1994-1996 study period, the estimated 6 percent share may be below the historical average. About 60 percent of all fertilizer flows originated in Louisiana and Mississippi with the remaining 40 percent shipped from Texas origins.

Table 2. Origin and Destination of Barge-Transported Downbound Trade Flows Involving the GIWW Below Corpus Christi Bay for Major Commodity/Product Groups

Downbound Movements					
Commodity/Product	**Origin**	**Destination**	**Tons**	**Tons**	**Tons**
			1994	**1995**	**1996**
Gasoline	Corpus Christi, TX	Harlingen, TX	466,901	537,882	468,087
	Corpus Christi, TX	Brownsville, TX	593,258	494,557	510,485
	Houston, TX	Brownsville, TX	37,130	6,654	16,951
	Texas City, TX	Harlingen, TX	0	0	6,954
	Houston, TX	Harlingen, TX	3,34 7	6,034	0
	Galveston, TX	Brownsville, TX	23,614	0	0
		TOTALS	1,124,250	1,045,127	1,002,477
Diesel	Corpus Christi, TX	Harlingen, TX	115,028	29,421	110,811
	Corpus Christi, TX	Brownsville, TX	12,765	98,156	96,274
	Houston, TX	Brownsville, TX	17,826	3,000	0
		TOTALS	145,619	130,577	207,085
Fuel Oil	Corpus Christi, TX	Harlingen, TX	0	7,396	14,164
	Corpus Christi, TX	Brownsville, TX	1,504	2,858	113,700

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Table 2. Continued.

Commodity/Product	Origin	Destination	Tons	Tons	Tons
			1994	1995	1996
Fuel Oil	Houston, TX	Brownsville, TX	339	0	0
	Corpus Christi, TX	Brownsville, TX	4,044	2,037	0
		TOTALS	5,887	12,291	127,864
Lubricating Oil	Louisiana	Brownsville, TX	2,923	3,384	3,302
	Louisiana	Brownsville, TX	912	7,500	7,200
	Houston, TX	Brownsville, TX	7,664	16,318	35,823
	Ohio	Brownsville, TX	8,066	10,044	10,340
	Pennsylvania	Brownsville, TX	6,842	2,788	10,102
	Port Arthur, TX	Brownsville, TX	4,611	3,812	0
	Beaumont, TX	Brownsville, TX	0	4,427	24,000
	Illinois	Brownsville, TX	0	0	1,450
		TOTALS	31,018	48,273	92,217
Dry Fertilizer and Other Chemicals	Louisiana	Harlingen, TX	15,856	4,785	0
	Louisiana	Brownsville, TX	4,542	0	5,931
		TOTALS	20,398	4,785	5,931

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Table 2. Continued.

Commodity/Product	Origin	Destination	Tons 1994	Tons 1995	Tons 1996
Liquid Fertilizer and Other Chemicals	Louisiana	Harlingen, TX	0	51,603	52,800
	Houston, TX	Brownsville, TX	89,999	11,200	5,396
	Matagorda, TX	Brownsville, TX	14,226	0	0
	Mississippi	Brownsville, TX	12,056	14,101	10,068
	Texas City, TX	Harlingen, TX	0	14,943	6,900
	Louisiana	Brownsville, TX	36,852	6,345	0
		TOTALS	153,133	98,192	75,164
Sand and Gravel	Louisiana	Harlingen, TX	4,854	0	0
	Corpus Christi, TX	Port Isabel, TX	5,191	0	0
	Victoria, TX	Port Isabel, TX	193,161	125,422	110,296
	Victoria, TX	Harlingen, TX	0	55,057	44,651
	Louisiana	Brownsville, TX	13,422	4,866	3,379
		TOTALS	216,628	185,345	158,326
Clay, Refractory Materials and Related Compounds	Corpus Christi, TX	Port Mansfield, TX	552	0	0
	Louisiana	Brownsville, TX	3,805	0	3,173

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Table 2. Continued.

Commodity/Product	Origin	Destination	Tons	Tons	Tons
			1994	1995	1996
Clay, Refractory Materials and Related Compounds	Houston, TX	Port Mansfield, TX	1,430	0	0
	Louisiana	Port Mansfield, TX	0	667	5,400
	Louisiana	Brownsville, TX	14,877	1,940	6,914
	Ohio	Brownsville, TX	9,261	0	1,402
	Illinois	Brownsville, TX	0	1,474	2,811
		TOTALS	29,925	4,081	19,700
Ores and Scrap Metals	Louisiana	Port Mansfield, TX	2,830	3,825	4,187
	Louisiana	Brownsville, TX	8,214	23,520	11,763
	Illinois	Brownsville, TX	2,855	0	0
	Houston, TX	Port Mansfield, TX	0	2,306	0
		TOTALS	13,899	29,651	15,950
Cement	Corpus Christi, TX	Harlingen, TX	21,443	7,112	27,561
		TOTALS	21,443	7,112	27,561
Primary Iron and Steel Products	Illinois	Brownsville, TX	2,772	0	0

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Table 2. Continued.

Commodity/Product	Origin	Destination	Tons	Tons	Tons
			1994	1995	1996
Primary Iron and Steel Products	Brownsville, TX	Port Mansfield, TX	6,331	0	0
	Houston, TX	Brownsville, TX	9,844	5,278	12,730
	Louisiana	Brownsville, TX	40,400	70,563	27,845
	West Virginia	Brownsville, TX	16,727	39,999	35,581
	Ohio	Brownsville, TX	12,219	14,900	46,431
	Ohio	Brownsville, TX	0	0	23,470
	Illinois	Brownsville, TX	0	0	5,649
		TOTALS	88,293	130,740	151,706
GRAND TOTAL			1,850,493	1,696,174	1,883,981

Table 3. Origin and Destination of Barge-Transported Upbound Trade Flows Involving the GIWW Below Corpus Christi Bay for Major Commodity/Product Groups

Upbound Movements					
Commodity/Product	**Origin**	**Destination**	**Tons**	**Tons**	**Tons**
			1994	**1995**	**1996**
Gasoline and Kerosene	Brownsville, TX	Louisiana	58,560	32,228	8,793
	Brownsville, TX	Houston, TX	22,455	0	0
		TOTALS	81,015	32,228	8,793
Crude Oil	Harlingen, TX	Texas City, TX	103,686	119,879	93,398
		TOTALS	103,686	119,879	93,398
Other Petroleum Oils	Brownsville, TX	Houston, TX	2,742	7,087	4,249
	Brownsville, TX	Corpus Christi, TX	0	10,528	0
	Harlingen, TX	Louisiana	3,053	0	0
		TOTALS	5,795	17,615	4,249
Manuf./Natural Gas	Harlingen, TX	Corpus Christi, TX	0	22,898	0
		TOTALS	0	22,898	0

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Table 3. Continued.

Commodity/Product	Origin	Destination	Tons	Tons	Tons
			1994	1995	1996
Mineral Products and Related Compounds	Brownsville, TX	Tennessee	18,999	8,979	12,747
	Brownsville, TX	Corpus Christi, TX	0	20,187	0
		TOTALS	18,999	29,166	12,747
Sand and Gravel	Brownsville, TX	Corpus Christi, TX	2,293	0	0
		TOTALS	2,293	0	0
Ores and Scrap Metal	Brownsville, TX	Louisiana	14,873	38,857	0
	Brownsville, TX	Illinois	0	0	4,685
		TOTALS	14,873	38,857	4,685
Cement	Port Isabel, TX	Harlingen, TX	1,565	0	0
		TOTALS	1,565	0	0
Processed Metals	Port Isabel, TX	Houston, TX	4,261	0	0
	Brownsville, TX	Tennessee	8,314	0	0
		TOTALS	12,575	0	0

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Table 3. Continued

Commodity/Product	Origin	Destination	Tons	Tons	Tons
			1994	1995	1996
Primary Iron and Steel Products	Brownsville, TX	Illinois	11,540	0	44,715
	Brownsville, TX	Louisiana	0	12,291	0
	Brownsville, TX	Beaumont, TX	0	0	15,682
		TOTALS	11,540	12,291	60,397
Sorghum	Harlingen, TX	Louisiana	0	0	25,506
		TOTALS	0	0	25,506
Cane Sugar	Harlingen, TX	New Orleans, LA	152,032	111,525	110,094
	Harlingen, TX	Galveston, TX	0	23,834	0
		TOTALS	152,032	135,359	110,094
GRAND TOTAL			404,373	408,293	319,869

Upbound Flows

During the 1994-1996 study period, upbound movements comprised about 17 percent of all tonnage transported on the GIWW below Corpus Christi Bay (Table 3). Sugar made up about 35 percent of all upbound flows while crude petroleum made up 28 percent of these shipments. Both products were shipped from Harlingen; sugar moved to a Louisiana destination while crude petroleum was transported to Texas refineries. Gasoline and kerosene shipments comprised about 11 percent of upbound shipments during the study period while iron and steel products made up about 10 percent.

Total Commodity/Product Flows

Processed petroleum products dominated the movement of commerce on the studied waterway. Over the study period, refined petroleum products comprised 64 percent of all tonnage moving on the waterway; about 96 percent of this tonnage was a downbound movement. Fertilizer, sand, and gravel, iron and steel products and sugar each comprised from 6 to 10 percent of all shipments. Other products of importance included cement, clay, and refractory materials, and ores and scrap metal.

Scenario 1 -- Estimated Barge Costs Associated with Historic Trade Flows

Initial transportation costing efforts focused on establishing benchmark costs representative of the current shallow draft barge movements on the GIWW below Corpus Christi Bay. The estimated benchmark costs were subsequently compared with alternative mode costs for purposes of determining the potential transportation cost savings associated with the current shallow draft barge transportation system. To accurately measure current barge costs it was necessary to gain insight on the distance of haul as well as the type of barge used on the movement and the likely tow size. This information was obtained from the Waterborne Commerce data and through telephone interviews with barge transportation companies, shippers, and receivers. Estimated barge costs were compared with current barge rates to determine the reasonableness of the estimated cost parameter. In general, estimated barge costs tended to approximate barge rates after adjusting for tow size, tow boat horsepower, and type of barge.

Included in tables 4 and 5 are average miles per trip, tons per barge and estimated barge costs for downbound/upbound shallow draft barge movements associated with all major commodity/product groups. As noted above the most important flow involved the transportation of refined petroleum products between Corpus Christi refineries and the ports at Brownsville and Harlingen. The majority of these products are transported in double-hulled tank barges that carry about 25,000 barrels per barge or 3000 tons; each dedicated tow typically includes two barges that are pushed by a 1600 horsepower tow boat. The cost of barge transportation between Corpus Christi and the lower Rio Grande Valley was estimated to be about $3.00 per ton which was found to closely approximate the current rate. Based on the analysis, the total cost of the downbound barge movement of refined petroleum products was estimated at $4.54 million (Table 4). Other downbound commodity/product movements that made important contributions to total barge transport costs included liquid nitrogen fertilizer ($1.01 million), sand, and gravel ($0.76 million), and primary iron and steel products ($1.64 million). The estimated total barge cost of the downbound movements was $8.51 million.

Table 4. Estimated Miles/Trip, Tons/Barge, Barge Costs/Ton, Average Barge-Transported Quantity and Total Barge Costs for Downbound Trade Flows Involving the GIWW Below Corpus Christi Bay for Major Commodity/Product Groups, 1994-1996

Downbound Movements							
Commodity/Product	**Origin**	**Destination**	**Miles/ Trip**	**Tons/ Barge**	**Estimated Barge Costs (\$/ton)**	**Average Tons Transported**	**Total Barge Cost (\$)**
Gasoline	Corpus Christi, TX	Harlingen, TX	150.63	3,381.33	2.79	490,956.70	1,369,769.1
	Corpus Christi, TX	Brownsville, TX	157.83	3,168.33	3.02	532,766.70	1,608,955.3
	Houston, TX	Brownsville, TX	367.53	2,947.83	5.47	20,245.00	110,740.2
	Texas City, TX	Harlingen, TX	331.00	3,177.00	4.24	2,318.00	9,828.3
	Houston, TX	Harlingen, TX	364.00	3,182.00	5.01	3,127.00	15,666.3
	Galveston, TX	Brownsville, TX	340.00	2,401.00	5.65	7,871.30	44,473.0
		TOTALS				1,057,284.70	3,159,432.2
Diesel	Corpus Christi, TX	Harlingen, TX	149.14	3,270.83	2.67	85,086.70	227,181.4
	Corpus Christi, TX	Brownsville, TX	155.50	3,291.67	2.87	69,065.00	198,216.6
	Houston, TX	Brownsville, TX	363.35	1,342.40	6.97	6,942.00	48,385.7
		TOTALS				161,093.70	473,783.7
Fuel Oil	Corpus Christi, TX	Harlingen, TX	149.25	3,619.50	2.75	7,186.70	19,763.3
	Corpus Christi, TX	Brownsville, TX	158.32	1,200.80	2.86	41,381.00	118,349.7
	Houston, TX	Brownsville, TX	369.00	339.00	19.63	113.00	2,218.2
		TOTALS				48,680.60	140,331.2

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Table 4. Continued.

Commodity/Product	Origin	Destination	Miles/ Trip	Tons/ Barge	Estimated Barge Costs ($/ton)	Average Tons Transported	Total Barge Cost ($)
Lubricating Oil	Louisiana	Brownsville, TX	682.33	1,548.50	16.35	3,203.00	52,369.1
	Louisiana	Brownsville, TX	451.57	1,171.67	10.50	5,204.00	54,642.0
	Houston, TX	Brownsville, TX	372.97	1,314.23	9.47	19,935.00	188,784.5
	Ohio	Brownsville, TX	2,345.40	1,411.50	20.17	9,483.30	191,278.8
	Pennsylvania	Brownsville, TX	2,367.53	1,400.00	22.59	6,577.30	148,582.0
	Port Arthur, TX	Brownsville, TX	395.00	1,160.00	9.75	2,807.70	27,375.0
	Beaumont, TX	Brownsville, TX	424.15	1,343.50	9.65	9,475.70	91,440.2
	Illinois	Brownsville, TX	1,580.00	1,450.00	22.56	483.30	10,903.3
		TOTALS				57,169.30	765,374.5
Dry Fertilizer and Other Chemicals	Louisiana	Harlingen, TX	724.00	1,589.00	7.43	6,880.30	51,120.9
	Louisiana	Brownsville, TX	776.35	1,498.00	7.49	3,491.00	26,147.6
		TOTALS				10,371.30	77,268.5
Liquid Fertilizer and Other Chemicals	Louisiana	Harlingen, TX	691.45	2,321.80	10.50	34,801.00	365,410.5
	Houston, TX	Brownsville, TX	408.03	1,837.67	6.99	35,531.70	248,366.4
	Matagorda, TX	Brownsville, TX	241.50	1,595.00	5.49	4,742.00	26,033.6
	Mississippi	Brownsville, TX	819.43	1,790.33	14.40	12,075.00	173,880.0
	Texas City, TX	Harlingen, TX	285.00	2,421.50	5.34	7,281.00	38,880.5
	Louisiana	Brownsville, TX	702.72	1,832.50	11.03	14,399.00	158,821.0
		TOTALS				108,829.70	1,011,391.9

(continued on next page)

Table 4. Continued.

Commodity/Product	Origin	Destination	Miles/ Trip	Tons/ Barge	Estimated Barge Costs ($/ton)	Average Tons Transported	Total Barge Cost ($)
Sand and Gravel	Louisiana	Harlingen, TX	644.00	1,508.00	8.49	1,618.00	13,736.8
	Corpus Christi, TX	Port Isabel, TX	70.50	805.00	2.34	1,730.30	4,048.9
	Victoria, TX	Port Isabel, TX	369.67	2,366.73	3.83	142,959.60	547,535.2
	Victoria, TX	Harlingen, TX	225.35	2,004.05	3.89	33,236.00	129,288.0
	Louisiana	Brownsville, TX	758.38	1,363.00	9.05	7,223.00	65,368.2
		TOTALS				186,766.90	759,977.1
Clay, Refractory Materials and Related Compounds	Corpus Christi, TX	Port Mansfield, TX	75.75	224.00	1.67	184.00	307.3
	Louisiana	Brownsville, TX	666.00	1,394.25	8.74	2,326.00	20,329.2
	Houston, TX	Port Mansfield, TX	319.00	476.50	5.17	476.70	2,464.4
	Louisiana	Port Mansfield, TX	542.00	434.25	7.01	2,022.30	14,176.6
	Louisiana	Brownsville, TX	783.70	1,352.17	8.86	7,910.30	70,085.6
	Ohio	Brownsville, TX	1,238.20	1,544.00	13.37	3,554.20	47,519.2
	Illinois	Brownsville, TX	1,798.00	1,439.75	14.63	1,428.30	20,896.5
		TOTALS				17,901.80	175,778.7
Ores and Scrap Metal	Louisiana	Port Mansfield, TX	558.00	693.07	8.70	3,614.00	31,441.8
	Louisiana	Brownsville, TX	758.27	1,369.80	9.12	14,499.00	132,230.9
	Illinois	Brownsville, TX	1,665.00	1,428.00	14.43	951.70	13,733.0
	Houston, TX	Port Mansfield, TX	337.00	708.70	9.63	768.70	7,402.6
		TOTALS				19,833.30	184,807.8

(continued on next page)

Table 4. Continued.

Commodity/Product	Origin	Destination	Miles/ Trip	Tons/ Barge	Estimated Barge Costs ($/ton)	Average Tons	Total Barge Cost ($)
Cement	Corpus Christi, TX	Harlingen, TX	205.67	684.00	6.42	18,705.30	120,088.2
		TOTALS				18,705.30	120,088.2
Primary Iron and Steel Products	Illinois	Brownsville, TX	1,930.00	1,386.00	18.27	924.00	16,881.5
	Brownsville, TX	Port Mansfield, TX	42.33	1,060.00	2.95	2,110.30	6,225.5
	Houston, TX	Brownsville, TX	411.10	1,101.00	6.02	9,284.00	55,889.7
	Louisiana	Brownsville, TX	806.27	1,407.43	10.03	46,269.30	464,081.4
	West Virginia	Brownsville, TX	2,221.93	1,255.00	17.42	30,769.00	535,996.0
	Ohio	Brownsville, TX	2,075.20	1,393.47	16.86	24,516.70	413,351.0
	Ohio	Brownsville, TX	1,963.30	1,552.90	14.83	7,823.30	116,020.0
	Illinois	Brownsville, TX	1,931.00	1,412.25	18.27	1,883.00	34,402.4
		TOTALS				123,579.70	1,642,847.5
GRAND TOTAL						1,810,216.30	8,511,081.3

[1] Based on 1994-1996 average tonnage

Table 5. Estimated Miles/Trip, Tons/Barge, Barge Costs/Ton, Average Barge-Transported Quantity and Total Barge Costs for Upbound Trade Flows Involving the GIWW Below Corpus Christi Bay for Major Commodity/Product Groups, 1994-1996

Upbound Movements							
Commodity/Product	**Origin**	**Destination**	**Miles/ Trip**	**Tons/ Barge**	**Estimated Barge Costs ($/ton)**	**Average Tons Transported**	**Total Barge Costs ($)**
Gasoline and Kerosene	Brownsville, TX	Louisiana	455.00	2,802.00	9.58	33,193.70	317,995.30
	Brownsville, TX	Houston, TX	396.70	3,256.00	5.91	7,485.00	44,236.30
		TOTALS				40,678.70	362,231.50
Crude Oil	Harlingen, TX	Texas City, TX	329.00	2,433.67	5.25	105,654.30	554,685.10
		TOTALS				105,654.30	554,685.10
Other Petroleum Oils	Brownsville, TX	Houston, TX	382.33	2,052.67	8.55	4,692.70	40,122.30
	Brownsville, TX	Corpus Christi, TX	114.00	3,344.00	3.56	3,509.30	12,493.20
	Harlingen, TX	Louisiana	679.00	1,527.00	14.57	1,017.70	14,827.80
		TOTALS				9,219.70	67,443.30
Manufactured/Natural Gas	Harlingen, TX	Corpus Christi, TX	148.00	2,308.00	4.31	7,632.70	32,896.80
		TOTALS				7,632.70	32,896.80
Mineral Products and Related Products	Brownsville, TX	Tennessee	1,827.33	1,447.33	12.99	13,575.00	176,339.30
	Brownsville, TX	Corpus Christi, TX	181.00	2,163.00	2.18	6,729.00	14,669.20
		TOTALS				20,304.00	191,008.50

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Table 5. Continued.

Commodity/Product	Origin	Destination	Miles/ Trip	Tons/ Barge	Estimated Barge Costs ($/ton)	Average Tons Transported	Total Barge Costs ($)
Sand and Gravel	Brownsville, TX	Corpus Christi, TX	198.00	726.00	4.31	764.30	3,294.30
		TOTALS				764.30	3,294.30
Ore and Scrap Metal	Brownsville, TX	Louisiana	831.00	1,249.50	13.80	17,910.00	247,158.00
	Brownsville, TX	Illinois	1,711.00	1,545.00	19.25	1,561.70	30,062.70
		TOTALS				19,471.70	277,220.70
Cement	Port Isabel, TX	Harlingen, TX	48.00	1,330.00	3.24	521.70	1,690.20
		TOTALS				521.70	1,690.20
Processed Metals	Port Isabel, TX	Houston, TX	379.00	1,330.00	5.35	1,420.30	7,598.60
	Brownsville, TX	Tennessee	1,549.00	1,432.00	13.40	2,771.30	37,135.40
		TOTALS				4,191.60	44,734.00
Primary Iron and Steel Products	Brownsville, TX	Illinois	1,934.00	1,392.50	18.71	18,751.70	350,844.30
	Brownsville, TX	Louisiana	899.00	1,215.00	8.94	4,097.00	36,627.20
	Brownsville, TX	Beaumont, TX	428.00	1,417.00	5.34	5,227.30	27,914.00
		TOTALS				28,076.00	415,385.50
Sorghum	Harlingen, TX	Louisiana	708.00	1,643.00	6.92	8,502.00	58,833.80
		TOTALS				8,502.00	58,833.80

(continued on next page)

Table 5. Continued.

Commodity/Product	Destination		Miles/ Trip	Tons/ Barge	Estimated Barge Costs ($/ton)	Average Tons Transported	Total Barge Costs ($)
Cane Sugar	Harlingen, TX	New Orleans, LA	676.00	1,538.00	6.92	124,550.30	861,888.10
	Harlingen, TX	Galveston, TX	329.00	1,584.00	3.33	7,944.70	26,455.80
		TOTALS				132,495.00	888,343.90
GRAND TOTAL						377,511.70	2,897,767.60

[1] Based on 1994-1996 average tonnage

The total barge cost associated with upbound movements was calculated to be $2.90 million (Table 5). Important contributors to this cost were cane sugar ($0.89 million), crude petroleum ($0.55), primary iron and steel products ($0.42 million), and gasoline and kerosene ($0.36 million). Upbound movements comprised about 25 percent of the estimated total upbound/downbound barge transportation costs of $11.41 million.

Alternative Transportation Modes and Mode Combinations

This section offers background on alternative transport modes that may be used to transport upbound/downbound commerce with closure of the GIWW below Corpus Christi Bay. Closure of this portion of the GIWW is expected to make all ports below Corpus Christi Bay inaccessible to shallow draft transportation. These include the ports at Mansfield, Harlingen, Pt. Isabel and Brownsville. The port of Brownsville would be accessible by ocean barge, thus consideration of this mode. Consideration is given to railroads, motor carriers, ocean barges, and the proposed pipeline.

Ocean barges

Ocean or off-shore barges are often dedicated to particular routes and operate under time charters. This is in contrast to many shallow draft operators which operate as tramps. The U.S. Army Corps of Engineers Port Series and telephone conversations with ocean barge operators were used as a guide to develop perspective on various commodity routings that would be likely candidates for ocean barge transportation. In general, adequate water depth and haul characteristics were judged appropriate for all downbound/upbound movements of gasoline, diesel and fuel oil entering/exiting the port of Brownsville and the majority of the downbound liquid nitrogen fertilizer movement to Brownsville. The portion of these products historically routed to Harlingen via shallow draft barge may be routed to Brownsville by ocean barge for transhipment and overland transportation to Harlingen after waterway closing. Similarly, it was presumed that the upbound shipment of sugar from Harlingen would be a candidate for transport to Brownsville for transhipment and subsequent ocean barge transportation to Louisiana and Texas ports.

Personnel with Jack Faucett Associates informed that labor costs, fuel costs and costs associated with the capital expenditure were critical in determining ocean barge costs. Based on this counsel, ocean barge cost budgets as estimated by the U.S. Army Corps of Engineers for the 1989-1990 period were updated to reflect 1997 costs. This was accomplished by estimating indices that permitted the transformation of the 1989-1990 costs to reflect the 1997 period. The indices were obtained by examining shallow draft budget costs (replacement costs, labor costs, fuel costs) as prepared by the U.S. Army Corps of Engineers, Water Resources Support Center for the 1989 through 1997 period and calculating the appropriate indices. Per hour tanker barge costs for 5000dwt/2000hp, 8000dwt/2400hp and 10000dwt/3000hp combinations were estimated as were dry bulk ocean barge costs for a 5000dwt/2000hp and 8000dwt/2400hp combinations (Table 6). The estimated per hour cost of ocean barge operation in combination with industry average speeds when loaded/unloaded, distance of haul and loading/unloading times in port were used to calculate per ton costs for the selected product routes. Estimated ocean barge costs for selected routes were subsequently discussed with industry personnel to develop perspective on their reasonableness. In general, the estimated ocean barge costs tended to approximate the rates

Table 6. Estimated Per Hour Ocean Barge Costs, 1997

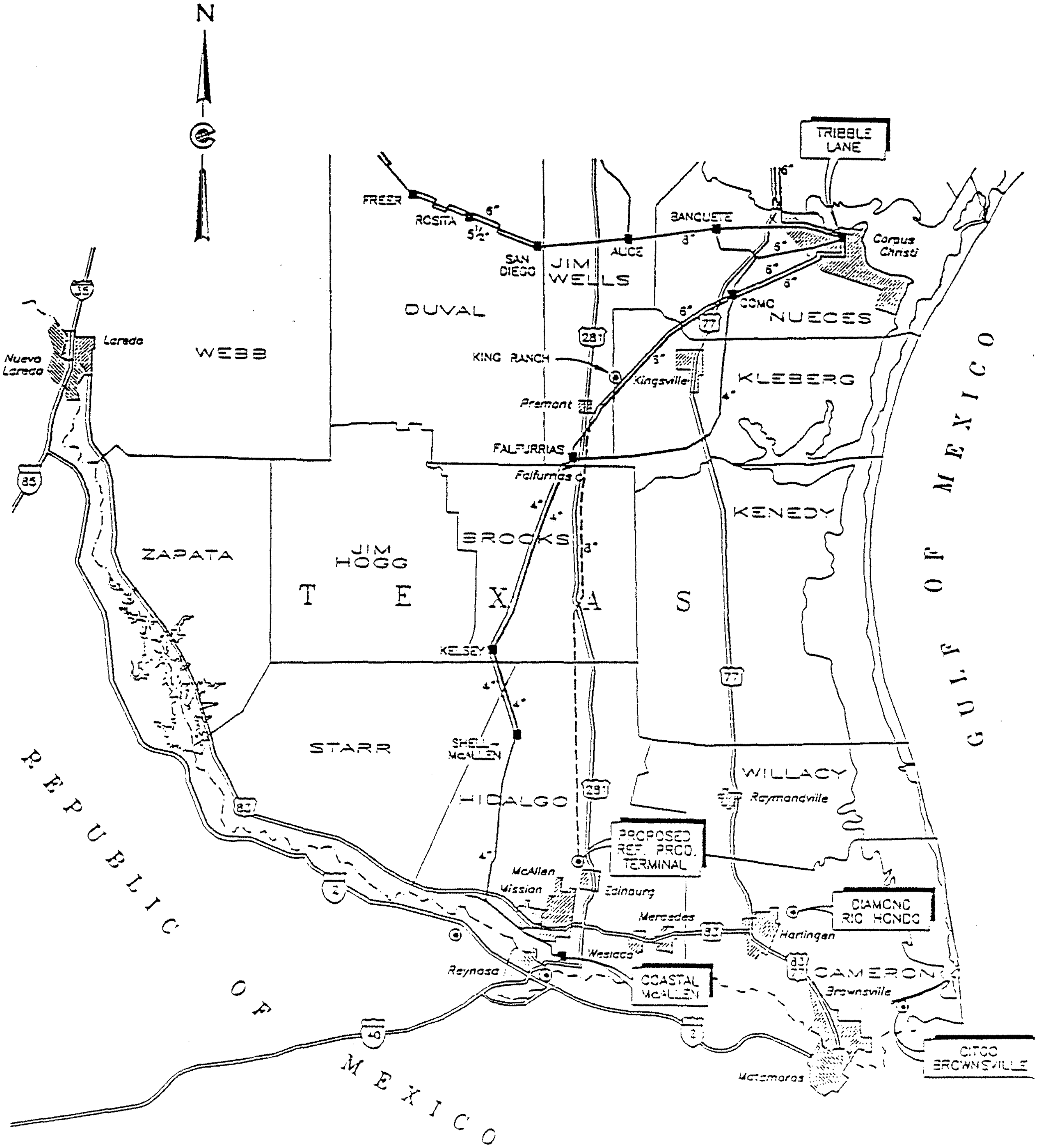
Barge Type	DWT	Horsepower	Tug	Fuel	Barge	In Port	Running
Drybulk	5000	2000	$202.89	$49.00	$67.67	$270.56	$319.57
Drybulk	8000	2400	$218.47	$58.79	$103.42	$321.89	$380.57
Tank	5000	2000	$202.89	$49.00	$66.64	$269.53	$318.53
Tank	8000	2400	$218.47	$58.79	$102.03	$320.50	$379.29
Tank	10,000	3000	$245.16	$73.50	$128.93	$374.08	$447.58

estimated by industry. Thus, the estimated costs were judged adequate to carry out study objectives.

Pipeline

Shallow draft barges moving via the GIWW below Corpus Christi Bay and a products pipeline are the principal transport modes currently transporting gasoline, diesel and fuel oil to the lower Rio Grande Valley market. It is estimated that barges have carried about 80 percent of this flow while the remaining market share was carried via pipeline. The pipeline links Coastal Corporations refining capacity in the Corpus Christi area with McAllen, Texas in Hidalgo county. The pipeline includes about 50 miles of 6-inch pipe that extends from Corpus Christi to Falfurrias, Texas and about 85 miles of 4-inch pipe that extends into the McAllen area. This pipeline is now operating at full capacity and because of the growth in the lower Rio Grande Valley petroleum products market, the Coastal Corporation has announced intentions to increase their pipeline capacity to the Valley. Plans call for using the existing 6-inch segment in combination with about 80 miles of new 8-inch pipe and associated right-of-way that would extend from near Falfurrias to a new storage terminal site at Edinburg, Texas which has planned storage capacity of about 150,000 barrels (Figure 3). The system will include one existing pump

Figure 3. Proposed Refined Products Pipeline System



LEGEND
- Refined Product P/L
- Proposed Ref. Prod. P/L
- Crude Pipeline
- Idle Pipeline

PROPOSED REFINED PRODUCTS
PIPELINE SYSTEM
LOWER RIO GRANDE VALLEY

station and two new pump stations with total horsepower of about 2500; all pump stations will be located on the 50 mile, 6-inch portion of the pipeline. The pipeline will be constructed to accommodate 1440 lbs of pressure per square inch and to transport up to 25,000 barrels per day. The new pipeline is connected to other refiners in the Corpus Christi area and will serve as a common carrier of refined petroleum products to the lower Rio Grande region. The pricing of pipeline transportation service is expected to be competitive with the shallow draft barge transportation that currently transports petroleum products between Corpus Christi refineries and terminals in the ports at Brownsville and Harlingen. The proposed pipeline represents an estimated investment of about $25 million.

Motor Carriers, Barges and Railroads

All truck, barge and railroad costs were estimated with the Reebie Associates cost models. In particular, these included the Truck Cost Analysis Model v6.2; Rail Cost Analysis Model v6.2; and Barge Cost Analysis Model v6.1. All transportation costs reflect the third quarter of 1997. Rail routings and associated mileages were obtained with ALK's PC*RAIL algorithm, a product of ALK Associates. Railroad costs are believed to be representative of the Union Pacific Southern Pacific system, the only carrier with trackage that will permit service in the study region. Telephone interviews were carried out with shippers/receivers and transportation company personnel to obtain detailed information on applicable mode characteristics and transportation rates for all major commodity/product routings. The detailed mode characteristic information facilitated the estimation of more accurate transportation costs with the Reebie models. In general, the estimated transportation costs were found to approximate quoted transportation rates.

Transhipment Models

To estimate transportation costs that would likely result with closure of the GIWW below Corpus Christi Bay, transhipment models were constructed for each product/commodity grouping. These models included transportation costs for alternative modes and mode combinations as well as any additional transhipment costs ($2.00/ton) and regional commodity/product demands and supplies. The transhipment models determine the least-cost mode or mode combinations and associated flow pattern given transportation/transhipment costs and supplies/demands. Consider, for example, downbound movements of refined petroleum products that may be routed via several different modes and mode combinations. First, Texas refineries may ship directly to demand locations in the Rio Grande Valley by truck/rail or second, they may ship by ocean barge to the port of Brownsville for terminal storage and subsequent truck delivery to Valley demand locations. Refined petroleum products that had historically been routed to Harlingen via shallow draft barge may now be carried to Brownsville via ocean barge for transhipment and subsequent delivery to the Harlingen refined petroleum market. Further, downbound refined petroleum products that originate in other areas than Corpus Christi may move to Corpus Christi by shallow draft barge for transhipment and subsequent routing by truck/rail to the lower Rio Grande Valley refined petroleum market. Because of the numerous routing and transportation alternatives for refined petroleum products and other commodities/products, the transhipment models were necessary for purposes of resolving the least-cost mode and mode combinations.

Scenario 2 -- Estimated Transport Costs that Result from GIWW Closure

Included in Tables 7 and 8 are the estimated shallow draft barge costs for the respective downbound/upbound traffic flows by commodity/product groups (Tables 6 and 7) and the projected transport costs that would likely result from closure of the GIWW below Corpus Christi Bay.

Downbound Flows

The analysis shows gasoline transportation costs would nearly double if shallow draft barge transportation were unavailable as a result of waterway closure. In particular, total transportation cost is expected to increase from about $3.16 million to $6.45 million (Table 7). Results show that gasoline originating at Corpus Christi refineries that had been routed to Brownsville and Harlingen via shallow draft barge would now be transported to Brownsville by ocean barge. That portion which had historically been destined to Harlingen would be transhipped at Brownsville for subsequent truck transport into the Harlingen gasoline market. The comparatively small quantities of gasoline that have historically originated in the Houston, Galveston, and Texas City area would move by shallow draft barge to Corpus Christi for transhipment and rail transport to Harlingen. The cost of transporting gasoline by ocean barge to Brownsville was estimated to be $4.35 million ($4.25/ton). Because of the need to serve the Harlingen gasoline market via truck shipments from Brownsville storage terminals, it was necessary to estimate the increased trucking costs associated with this additional distance of haul. The additional trucking cost was estimated to be $1.69 million while the transport costs associated with shallow draft barge transportation to Corpus Christi and the subsequent rail transport to Harlingen were estimated at $0.41 million. The sum of these costs is equal to the total cost estimate presented for gasoline in Table 7 ($4.35 + $1.69 + $0.42 = $6.45).

The cost of transporting diesel, fuel oil, and lubricating oil were also estimated to about double as a result of waterway closure (Table 7). In particular, diesel transport cost was projected to increase from $0.47 to $1.14 million while fuel oil transport cost increases from $0.14 to $0.28 million and lubricating oil transport cost increases from $0.77 million to $1.15 million. Ocean barge is used to route diesel and fuel oil from Corpus Christi and Houston to Brownsville while shipments from Corpus Christi to Harlingen are rail-transported. In contrast to the gasoline solution, very small quantities of diesel and fuel oil are transhipped at Brownsville for subsequent truck transport to the Harlingen market. This is because of a smaller and comparatively less efficient ocean barge ($4.25/ton versus $5.74/ton) that was presumed to be used for the relatively small quantities of fuel oil and diesel movements from Corpus Christi to Brownsville. Thus, the projected rail routing from Corpus Christi to the Harlingen market. Lubricating oil supplies that originated in Texas were rail-transported to the Harlingen and Brownsville markets while out-of-state supplies (Louisiana, Pennsylvania, Illinois) moved by shallow draft barge to Corpus Christi for transhipment and subsequent rail transport to the Harlingen and Brownsville markets.

Closure of the GIWW is projected to have a comparatively dramatic affect on the cost of transporting sand and gravel (Table 7). Downbound transport cost are projected to increase from $0.76 to $2.76 million. About 95 percent of the downbound sand and gravel movement originates on the Guadalupe River near Victoria, Texas. Over three-fourths of this sand and gravel are destined for Pt. Isabel with the remainder routed to the Harlingen area. Because of the

Table 7. Estimated Transportation Costs That Result From Closure of GIWW Below Corpus Christi Bay for Downbound Trade Flows by Major Commodity/Product Groups

	Downbound Movements		
Commodity/Product	Current Transport Cost ($1000)	Projected Transport Cost ($1000)	Projected Increase in Transport Cost ($1000)
Gasoline	3,159.40	6,454.00	3,294.60
Diesel	473.80	1,142.50	668.70
Fuel Oil	140.30	284.70	144.40
Lubricating Oil	765.40	1,150.70	385.30
Dry Fertilizer and Other Chemicals	77.30	148.00	70.70
Liquid Fertilizer and Other Chemicals	1,011.40	1,566.10	554.70
Sand and Gravel	759.90	2,759.40	1,999.50
Clay, Refractory Materials and Related Compounds	175.80	343.40	167.60
Ores and Scrap Metal	184.80	461.80	277.00
Cement	120.10	156.20	36.10
Primary Iron and Steel Products	1,642.80	2,460.20	817.40
TOTAL	8,511.10	16,927.00	8,416.00

Table 8. Estimated Transportation Costs that Result from Closure of the GIWW Below Corpus Christi Bay for Upbound Trade Flows by Major Commodity/Product Groups

Upbound Movements			
Commodity/Product	Current Transport Cost ($1000)	Projected Transport Cost ($1000)	Projected Increase in Transport Cost ($1000)
Gasoline and Kerosine	362.20	433.20	71.00
Crude Oil	554.70	1,479.20	924.50
Other Petroleum Products	67.40	89.80	22.40
Manufactured and Natural Gas	32.90	61.40	28.50
Mineral Products and Related Compounds	191.00	412.20	221.20
Sand and Gravel	3.30	7.10	3.80
Ores and Scrap Metal	277.20	403.80	126.60
Cement	1.70	7.10	5.40
Processed Metals	44.70	124.90	80.20
Primary Iron and Steel Products	415.40	624.90	209.30
Sorghum	58.80	115.90	57.10
Cane Sugar	888.30	2,139.70	1,251.40
TOTAL	2,897.60	5,899.00	3,001.40

unavailability of rail service at the source of sand and gravel supply all shipments are truck-transported, thus the relatively dramatic increase in transportation costs. All remaining sand and gravel movements are transported by rail.

The transportation cost associated with the downbound movement of primary iron and steel products is projected to increase from $1.64 million to $2.46 million (Table 7). Results show out-of-state supplies of these products would be routed to Corpus Christi by shallow draft barge where they would be transhipped for subsequent rail shipment to Brownsville. Primary iron and steel products shipped from Texas origins are shipped directly by rail to Brownsville.

Closing the GIWW below Corpus Christi Bay is projected to increase total transport cost from $8.51 million to $16.93 million, a 99 percent increase in transport cost. Results indicate that about 63 percent of the downbound movement would move directly from origin to destination by truck, rail or ocean barge while remaining quantities (37%) would tranship at Corpus Christi for subsequent movement to the lower Rio Grande Valley area.

Upbound Flows

Transportation costs associated with cane sugar, the leading upbound movement, is projected to increase from $0.89 million to $2.14 million as a result of closing the GIWW below Corpus Christi Bay (Table 8). The analysis show the least-cost alternative to the current shallow draft barge would involve rail shipments from Harlingen to Louisiana and southeast Texas demand centers. Crude oil, the second most important upbound movement, is projected to have its transport costs increase from $0.55 million to $1.48 million as a result of waterway closure. The analysis projects crude oil to be routed from Harlingen to Corpus Christi by railroad where it is transhipped and subsequently shipped to demand centers in southeast Texas by shallow draft barge.

Closure of the waterway is projected to increase total upbound costs from $2.90 million to $5.90 million, an increase of slightly over 100 percent. About two-thirds of the rerouted commodities/products move directly by truck, railroad or ocean barge while the remaining one-third are shipped to Corpus Christi where they are transhipped for subsequent movement on shallow draft barges. See Appendix A for additional detail regarding estimated transportation costs after closure of the GIWW below Corpus Christi Bay.

Effect of the Proposed Refined Petroleum Product Pipeline on GIWW Traffic

This section presents analysis designed to determine (1) the effect of the proposed pipeline on downbound movements of refined petroleum products by shallow draft barge (scenario 3) and (2) the effect of closing the GIWW below Corpus Christi Bay on downbound movements of refined petroleum products by the proposed pipeline and other transportation modes (scenario 4). The analysis is designed to offer improved insight on the transportation benefits of the GIWW given implementation of the proposed pipeline.

To accomplish objectives associated with scenarios 3 and 4, a framework was developed that replicated the profit-maximizing behavior of the proposed pipeline. This perspective was thought to be appropriate for identifying the role of waterborne transportation in supplying petroleum products to the lower Rio Grande Valley region.

The developed transhipment model required substantial information. In particular, it was necessary to (1) estimate the demand for refined petroleum products (gasoline, diesel, fuel oil) in the lower Rio Grande Valley by geographic subregion, (2) estimate refined petroleum trucking costs that link storage terminal sites (Brownsville and Harlingen are marine-served terminals while Edinburg is the terminal site for proposed pipeline) to subregion demands in the lower Rio Grande Valley, (3) estimate shallow draft and ocean barge costs that link refined petroleum supply locations to marine-served terminal sites at Brownsville/Harlingen as well as other costs that would unfavorably influence the competitive position of barge transportation relative to the proposed pipeline, and (4) estimate supplies of refined petroleum products that are available for transport to the lower Rio Grande Valley area.

Lower Rio Grande Valley refined petroleum demand was estimated with information obtained from the Texas Comptroller of Public Accounts, Waterborne Commerce data, and conversations with petroleum industry personnel. Gasoline demand was estimated to be 1.311 million tons while diesel and fuel oil demand was estimated to be 0.207 and 0.064 million tons, respectively. These demands were subsequently allocated to study area subregions by population. A region encompassing all except the western-most portion of Cameron county was estimated to include 35 percent of demand (Brownsville region) while the remainder of Cameron county (western-most portion of county) was estimated to include about 10 percent of demand (Harlingen region). A region including Starr county and all of Hidalgo county except the eastern-most portion was estimated to include about 45 percent of demand (McAllen region) while the remaining area (eastern-most portion of Hidalgo county) was estimated to include 10 percent of demand (Weslaco region). See Figure 3.

Road mileages from the three storage terminal sites (Brownsville, Harlingen, Edinburg) to the four demand regions (Brownsville, Harlingen, McAllen, Weslaco) in combination with the

Reebie truck cost model gave estimated costs of distributing gasoline, diesel and fuel oil in the study region. The costs of transporting the refined products from supply locations to terminal sites at Brownsville/Harlingen by barge, ocean barge, truck and rail were those estimated for scenarios 1 and 2. Further research suggested that barge transportation may include additional costs that should be taken into account when evaluating the competitiveness of waterborne commerce relative to that of pipeline operations. These included the additional loading/unloading costs associated with barge transportation as well as port fees, insurance and demurrage. The additional cost of barge transportation was estimated to be $2.00 per ton. Refined petroleum product supplies were those included in the above scenarios; in addition, it was assumed that the proposed pipeline connecting the Corpus Christi refining industry to the lower Rio Grande Valley region would have necessary refined product supplies to maximize their profit.

After including the above information into a transhipment model, a variety of pipeline tariffs were analyzed with the transhipment model to determine the revenue-maximizing tariff for the pipeline as well as market shares held by the pipeline, barges and other transport modes. It was assumed that the revenue-maximizing throughput for the pipeline would approximate the profit-maximizing output because of the very high fixed costs associated with pipeline operations. It is estimated that fixed costs represent about 75 percent of total costs for many pipeline systems.

Scenario 3 -- Effect of Proposed Pipeline on Shallow Draft Barge Traffic

The analysis shows the proposed pipeline would have an important affect on the quantity of refined petroleum products transported to the lower Rio Grande Valley by shallow draft barge. The proposed expansion of pipeline capacity is projected to reduce the quantity of refined petroleum products carried by shallow draft barge from 1.260 million tons to 0.871 million tons while pipeline-carried product increases from 0.322 to 0.711 million tons. The ports at Brownsville and Harlingen are projected to experience important reductions in the quantity of refined petroleum product handled, however, the greatest decline is projected for Harlingen where quantities handled decline over 50 percent.

The analysis projects the proposed pipeline would generate revenues of $4.62 million with a profit-maximizing tariff of $6.50 per ton. The pipeline is projected to transport 0.711 million tons or about 60 percent of its annual capacity. The comparatively high tariff charged by the pipeline ($6.50/ton for pipeline versus about $3.00/ton for barge) is due to the additional port fees, insurance, demurrage and loading/unloading cost attributed to barge transport (estimated at $2.00 per ton) and the location advantage of the pipeline terminal at Edinburg relative to the demand centers in Hidalgo and Starr counties.

Scenario 4 -- Effect of GIWW Closure on Transportation Costs with Proposed Pipeline in Operation

Closing the GIWW below Corpus Christi Bay increases the role of the proposed pipeline in meeting refined petroleum demands in the lower Rio Grande Valley. This is expected since shallow draft barge transportation to the Harlingen/Brownsville terminals would no longer be available and alternative modes are relatively less efficient. Based on the assumed profit-maximizing behavior of the proposed pipeline, pipelines would serve 55 percent (0.869 million tons) of the Valley's refined petroleum market while ocean barge would transport a 35 percent share (0.555 million tons) and railroads a 10 percent share (0.158 million tons) if the waterway were closed. The analysis shows the proposed pipeline would generate revenues of about $8.69 million with an estimated profit-maximizing tariff of $10.00 per ton of transported petroleum product.

To develop insight on the transportation benefits of the GIWW, transportation costs/charges associated with scenarios 3 and 4 were contrasted. In this analysis, the downbound costs/charges of transporting the refined petroleum product from supply locations to the lower Rio Grande Valley are considered as well as the estimated trucking costs of distributing the product from the terminal sites (Brownsville, Harlingen, Edinburg) to the four demand regions (Brownsville, Harlingen, Weslaco, McAllen) in the Valley. The analysis shows the downbound cost/charges associated with gasoline would increase $4.23 million per year if the proposed pipeline were operational and the GIWW below Corpus Christi were closed to shallow draft barge transportation. This increase is attributable to the increased cost associated with using the less efficient ocean barge and the $3.50 per ton increase in the pipeline tariff ($6.50 to $10.00/ton) that is facilitated by the reduced competitiveness of the ocean barge. Downbound transportation costs are projected to increase $0.78 and $0.24 million for diesel and fuel oil, respectively, with waterway closure while trucking costs associated with distributing the product in the Valley decline modestly ($0.08 million). In summary, transportation costs associated with supplying the lower Valley with refined petroleum products is projected to increase about $5.17

million per year if the proposed pipeline is made operational and the GIWWbelow Corpus Christi is closed.

Study Limitations

The analysis assumes that the historic quantities shipped between the origins and destinations identified in the Waterborne Commerce data set would continue in each of the analyzed scenarios. It seems likely that some origins and destinations as well as quantities transported between origins and destinations would change if shallow draft barge transportation on the GIWW below Corpus Christi Bay were abandoned. Further, it was assumed that the measured change in transportation cost that is projected to occur with closure of the GIWW (scenario 1 versus scenario 2) would approximate the change in expenditures for transportation service. If a competitive transportation environment does not evolve, the measured cost may tend to underestimate the change in expenditures.

The analysis which focuses on the proposed pipeline and its impact on shallow draft barge transportation of petroleum products on the GIWW below Corpus Christi Bay (scenario 3) and the associated measurement of transportation benefits of the GIWW (scenario 4) was based on estimated parameters that could not be validated by industry sources. A follow-up study carried out after completion of the pipeline is probably desirable. Further, a study which measures the change in emissions and roadway congestion that would likely result with waterway closure would add important information regarding the benefits of the GIWW below Corpus Christi Bay.

Conclusions

The purpose of this study was to measure the transportation benefits associated with the GIWW below Corpus Christi Bay. Four scenarios were developed and evaluated for purposes of accomplishing study objectives. The first scenario (scenario 1) measured total transport cost associated with current shallow draft barge operations on the waterway while scenario 2 measured total transportation costs of alternative modes and mode combinations that would likely be adopted if the waterway were closed. Transportation costs associated with scenarios 1 and 2 were compared to obtain a measure of transportation cost benefits of the examined waterway. Because of a recently proposed refined petroleum pipeline that is to connect the petroleum refining capacity in the Corpus Christi area to demands in the lower Rio Grande Valley, two additional scenarios were developed and evaluated. The third scenario (scenario 3) attempts to measure transportation costs and market shares for the proposed pipeline and shallow draft barge given operationalization of the proposed pipeline. The fourth scenario (scenario 4) is designed to measure transportation costs and market shares for the proposed pipeline and other transport modes given shallow draft barge transportation is no longer available because of waterway closure. By contrasting scenarios 3 and 4, the transportation benefits of the waterway are measured given operation of the proposed petroleum product pipeline.

Analysis shows closing the GIWW would about double the total transportation and transhipment costs associated with current commodity/product flows on the waterway (scenario 1 versus scenario 2). The higher costs result from the unavailability of the shallow draft barge as well as the additional transhipment costs that would likely occur. In particular, costs are projected to increase from $11.41 million to $22.83 million per year with closure of the GIWW below Corpus Christi Bay. Results show that implementation of the proposed petroleum product pipeline would reduce the current role of shallow draft barge in transportation of these products to the lower Rio Grande Valley, regardless, closing the waterway would substantially increase cost/charges associated with transportation of these products (scenario 3 versus scenario 4). Transportation costs associated with the transportation of petroleum products to the Valley region is projected to increase about $5.17 million per year given operationalization of the proposed pipeline and closure of the waterway. In summary, although modest quantities of commodities/products are currently transported via the examined waterway, its closure would appear to have important implications for selected enterprises that depend on the transportation service of the shallow draft barge.

Appendix A

Tables A1, A2, and A3 provide additional information regarding the estimated commodity and product transport costs that result after closure of the GIWW below Corpus Christi Bay. Table A1 relates portion of transportation costs that are attributable to direct and transhipped movements after closure of the GIWW. A direct movement is one that moves directly from origin to destination via a particular transport mode. In contrast, a transhipped movement is transported from an origin to an intermediate point (transhipment location) where it is transferred to another mode for final movement to a destination. For example, Table A1 shows 41 and 59 percent of total gasoline transport cost were attributed to direct and transhipped movements, respectively, after closure of the GIWW while 75 and 25 percent of liquid fertilizer/chemical movements were due to direct and transhipped movements, respectively. Table A2 relates the portion of direct transport costs that are attributable to various modes. For example, 100 percent of the direct transport costs for gasoline can be attributed to ocean barge, whereas, for liquid fertilizer/chemicals the respective cost shares are 65 and 35 percent for ocean barge and rail (Table A2). Table A3 and A4 provides transport cost information about the transhipped movements. This cost information is segregated into "shipments to transhipment locations"(Table A3) and "shipments from transhipment locations" (Table A4). For gasoline shipments to transhipments locations, an estimated 2 and 98 percent of these transport costs was due to shallow draft and ocean barge, respectively (Table A3). The shallow draft gasoline movements represent flows from refineries in the Houston area to Corpus Christi where the cargo was transhipped to another mode for final movement to a study region destination. The ocean barge movements represent flow from Corpus Christi refineries to Brownsville where gasoline was transferred to another mode for final delivery to a study region destination. Because of the projected closing of the GIWW below Corpus Christi Bay, shallow draft barge would not be available to transport the substantial quantities of gasoline which moves to terminals in Harlingen, thus the need to tranship gasoline at Brownsville for subsequent movement to Harlingen. All (100%) of the liquid fertilizer/chemical was found to move to a transhipment location (Corpus Christi) via ocean barge for subsequent delivery via an alternative mode to a study region destination (Table A3). Table A4 shows 96 percent of gasoline transport cost associated with shipments from transportation locations was associated with the truck mode while 4 percent was due to railroad. The trucking costs were associated with transportation of the gasoline from Brownsville (transhipment location) to Harlingen while railroad costs reflect gasoline movements from Corpus Christi to a study region destination (Table A4). Table A4 show 100 percent of the liquid fertilizer/chemical costs associated with transportation from transhipment locations to be attributable to the truck mode.

Table A1. Estimated Percent of Total Transport Cost Attributed to Direct and Transhipped Movements for Major Commodity/Product Groups After Closure of GIWW Corpus Christi Bay

Commodity/Product	Direct (%)	Transhipped (%)
Gasoline	41.0	59.0
Diesel	93.0	7.0
Fuel Oil	99.0	1.0
Lubricating Oil	44.0	56.0
Dry Fertilizer/Chemicals	0.0	100.0
Liquid Fertilizer/Chemicals	75.0	25.0
Sand/Gravel	100.0	0.0
Clay/Refractory Materials	4.0	96.0
Ores/Scrap	15.0	85.0
Cement	100.0	0.0
Primary Iron/Steel	38.0	62.0
Crude Oil	78.0	22.0
Cane Sugar	100.0	0.0

Table A2. Estimated Percent of Total Transport Cost Attributed to Modes Involved in Direct Movements for Major Commodity/Product Groups After Closure of GIWW Below Corpus Christi Bay

Commodity/Product	Ocean Barge (%)	Rail (%)	Truck (%)
Gasoline	100.0	0.0	0.0
Diesel	41.0	59.0	0.0
Fuel Oil	80.0	20.0	0.0
Lubricating Oil	0.0	100.0	0.0
Liquid Fertilizer/Chemicals	65.0	35.0	0.0
Sand/Gravel	0.0	18.0	82.0
Clay/Refractory Materials	0.0	0.0	100.0
Ores/Scraps	0.0	0.0	100.0
Cement	0.0	95.0	5.0
Primary Iron/Steel	0.0	95.0	5.0
Crude Oil	100.0	0.0	0.0
Cane Sugar	0.0	100.0	0.0

Table A3. Estimated Percent of Total Transport Cost Attributed to Modes Involved in Transportation to Transhipment Locations for Major Commodity/Product Groups After Closure of GIWW Below Corpus Christi Bay

	Transportation to Transhipment Locations			
Commodity/Product	Shallow Draft Barge (%)	Ocean Barge (%)	Rail (%)	Truck (%)
Gasoline	2.0	98.0	0.0	0.0
Diesel	0.0	100.0	0.0	0.0
Fuel Oil	0.0	100.0	0.0	0.0
Lubricating Oil	100.0	0.0	0.0	0.0
Dry Fertilizer/Chemicals	100.0	0.0	0.0	0.0
Liquid Fertilizer/Chemicals	0.0	100.0	0.0	0.0
Clay/Refractory Materials	100.0	0.0	0.0	0.0
Ores/Scrap	52.0.	0.0	48.0	0.0
Primary Iron/Steel	100.0	0.0	0.0	0.0
Crude Oil	0.0	0.0	100.0	0.0

Table A4. Estimated Percent of Total Transport Cost Attributed to Modes Involved in Transportation from Transhipment Locations for Major Commodity/Product Groups After Closure of GIWW Below Corpus Christi Bay

	Transportation from Transhipment Locations		
Commodity/ Product	Ocean Barge (%)	Rail (%)	Truck (%)
Gasoline	0.0	4.0	96.0
Diesel	0.0	0.0	100.0
Fuel Oil	0.0	0.0	100.0
Lubricating Oil	0.0	100.0	0.0
Dry Fertilizer/Chemicals	0.0	100.0	0.0
Liquid Fertilizer/Chemicals	0.0	0.0	100.0
Clay/Refractory Material	0.0	80.0	20.0
Ores/Scrap	58.0	42.0	0.0
Primary Iron/Steel	0.0	100.0	0.0
Crude Oil	100.0	0.0	0.0

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